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Skylab Support
Progress Report, June 1975

Subcontract #1 Prime NAS9-13332

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Skylab Support
Progress Report, June 1975

The following report serves to report progress for June 1975 on Subcontract #1 of contract NAS9-13332. The financial reports for this contract are being submitted under separate cover.

The objective of this subcontract is to support the Skylab EREP effort of Michigan State University by: 1) performing standard recognition processing and producing recognition maps and area counts, 2) assisting in the analysis and interpretation of the recognition maps and other extracted information, 3) further developing and adapting, for use on Skylab EREP data, methods for estimating proportions of unresolved objects, and 4) applying proportion estimation techniques to one frame of EREP data to determine to what extent the accuracy of crop acreage estimates is improved.

The monthly reports for April and May described in detail the training procedure used to create three training signatures based, respectively, on 40, 20, and 10 sections from the northern portion of the ground truth area. These signature sets were composed of the SDO's given below.

Training Set	SDOs	Total No. of SDOs
40 Secs.	2, 8, 10, 12, 15, 17, 18	7
20 Secs.	2, 8, 10, 12, 14, 15, 17, 18	8
10 Secs.	2, 10, 12, 14, 15, 17	6

The number of ground cover classes represented by the spectral signatures decreased as the number of sections used for training decreased. Selecting the training sections on a random basis meant that some ground covers were no longer represented by the training signatures. The 40 section training set included seven ground cover classes, corn, grass, soybeans, trees, brush, alfalfa and bare soil, The 20 section training set contained only five ground cover classes omitting soybeans and alfalfa, and the 10 section training set did not have a signature for trees leaving only four ground cover classes.

The May monthly report described the results of center field recognition. Recognition using only center field pixels is pursued to evaluate training procedures and to determine how accurately the training signatures recognize the ground covers of interest. However, estimates of crop acreages and proportional estimates require recognition of all pixels including those pixels which contain two or more ground cover classes (mixture pixels) and boundary pixels.

Recognition results were tabulated for all pixels section by section over all forty sections using each of the training signature sets. The root mean square (RMS) error was then calculated for each section and for each ground cover class to evaluate recognition accuracy. An overall RMS error was also obtained. The RMS error was calculated as follows:

$$E_{RMS} \quad \frac{1}{N} \sum_{i=1}^{n} (p_i - \hat{p}_i)^2$$

where, p_i = ground truth proportion for one ground cover for one section

and $\hat{p}_i$ = estimated proportion for the same ground cover for the same section

and N = number of sections

or number of ground cover classes

or number of sections X number of ground cover classes

The ground truth available did not distinguish between trees and brush so the proportions from those two signature classes were combined for the calculation of RMS error. Although there was not a training signature for stubble, it was one of the ground truth classes so the stubble ground truth proportion was added to that for grass. The proportion of unclassified pixels was compared to the proportion of other ground covers which were not individually defined in the tabulated ground truth.

The RMS error was first calculated based on seven ground cover classes, corn, woods, soybeans, alfalfa, grass, bare soil and other. Since the number of signature classes changed as the number of sections used for training decreased, the RMS error was also calculated for the five signature classes found in all three training signature sets. For the five ground cover class calculations, the soybean and alfalfa proportions were added to the class, other.

Instead of listing the RMS error for all forty sections for the three different training sets, Table I gives the highest and lowest error calculated for each training set. In general, both the highest and lowest error estimate increased as the number of sections used for training decreased. However, the highest RMS error for the 20 section training set was slightly lower than the highest with forty section training for calculations based on either seven or five ground cover classes. Errors calculated on the basis of five ground covers are consistently higher than those based on seven ground covers even for the 20 and 10 section training sets where absence of soybean and alfalfa signatures meant those pixels could not correctly recognized. This suggests among other things that soybeans and alfalfa probably were not unclassified but were instead incorrectly recognized by one or more of the remaining signatures.

		40 SEC.	20 SEC.	10 SEC.
SEVEN GROUND COVERS	Highest Lowest	16.753 (LE11) 2.398 (LE6)	15.685 (LE4) 4.033 (LE6)	23.433 (LE4) 4.469 (LO34)
FIVE GROUND COVERS	Highest Lowest	21.627 (LE11) 3.270 (LE5)	19.205 (LE4) 4.739 (LE6)	27.869 (LE4) 6.064 (LO6)

TABLE 1

The Highest and lowest RMS errors for individual sections using different training signature sets calculated on the basis of 7 ground covers and 5 ground covers. The section number is given in the parenthesis, i.e., LE11 is Leroy township, Section 11, and LO34 is Locke Township, Section 34.

Tables I and II give the RMS errors calculated over ground cover class, as well as the overall RMS error, for respectively 7 and 5 ground cover classes. Basically, these Tables reflect the same trends exhibited in Table I. The overall RMS error increases as the number of sections used for training decreases, and five ground cover classes generate a higher overall RMS error than seven. The ground cover classes each show the same trend with two exceptions. The largest RMS error for the bare soil class is for the 20 section training set instead of the 10 section, but the difference between the two error values is small. The class which deviates largely is other. For both seven and five ground cover classes, the RMS error decreases as the number of training sections decreases. The decrease is very dramatic when five ground cover classes are used.

	CORN	ALFALFA	WOODS	SOYBEANS	SOIL	GRASS	OTHER	OVERALL
40 Sec	13.743	4.031	7.418	4.973	4.363	9.453	5.901	7.834
20 Sec	17.183	4.834	11.918	5.824	5.264	11.072	5.546	9.842
10 Sec	23.110	4.834	16.927	5.824	4.931	12.416	4.942	12.448

TABLE II. Overall RMS error and RMS error calculated per ground cover class for seven classes for 40, 20, and 10 sections training sets.

	CORN	WOODS	SOIL	GRASS	OTHER	OVERALL
40 Sec.	13.743	7.418	4.363	9.453	19.839	8.665
20 Sec.	17.183	11.918	5.264	11.072	12.141	11.046
10 Sec.	23.110	16.927	4.931	12.416	6.629	14.279

TABLE III. Overall RMS error and RMS error calculated per ground cover class for five classes for 40, 20, and 10 section training sets.

During the coming month we intend to tabulate the cost information for the training and processing of the North area and to classify and evaluate the recognition results for the Southern part of the test area. We will also try to improve proportional estimation by the use of mixture techniques which try to account for the fact that some of the pixels represent more than one ground cover type.

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